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ABSTRACT

A study of language patterning as an indicator of higher cortical process focused on three matched comparison groups: normal pre-middle-aged, normal elderly, and elderly adults with senile dementia Alzheimer's type. In addition to tests of memory, level of cognitive function, and organic deficit, the formal aspects of language were analyzed in these 60 individuals through tests of phonology, morphology, syntax, and semantics. Significant differences in linguistic processing between the comparison groups were found, and the findings suggest that there is a fundamental correlation between the degree of organic impairment and the degree of linguistic decrement, and a direct relationship beween normative denotation and connotation and organic intactness. The process of senile dementing appears to be a process of dedifferentiation in which the person can no longer respond to complexities of the cortical realm. The progressive incapacity of the elderly parson with Alzheimer's dementia to code and decode within the normative range is similar to a process of desocialization, and in this process, the two lines of thought and language, or meaning and sound, which merged at one point in development, now begin to separate. A direct relationship is found between linguistic deficits and linguistic complexity, with a concomitant inverse relationship between linguistic deterioration and sequence in language development. Tables and references conclude the document. (MSE)

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Abstract
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LINGUISTIC DETERIORATION IN ALZHEIMER'S SENILE DEMENTIA AND IN NORMAL AGING *

The paper describes the investigation of language patterning, as indicator of higher cortical process, in comparison groups of normal pre-middle-aged, normal elderly, and elderly adults with senile dementia Alzheimer's type. Structure of linguistic deficits is analyzed with the finding that linguistic decrement is not random. There is a direct correlation between organic deficit and linguistic deficit. Further, there is direct relationship between linguistic deficits and linguistic complexity, with a concomitant inverse relation between linguistic deterioration and sequence in language development. Significant differences in linguistic processing exist between the comparison groups; these differences are analyzed.

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LINGUISTIC DETERIORATION IN ALZHEIMER'S SENILE DEMENTIA AND IN NORMAL AGING

The study to be discussed involved the investigation of language patterning, as an indicator of higher order mental processes (Luria, 1980), in the comparison groups of normal pre-middle-aged adults, normal elderly adults, and elderly adults with senile dementia Alzheimer's type. The study was exploratory with the following objectives: (1) to establish methods for the investigation of linguistic patterning in adulthood in both normal and pathological manifestations, (2) to analyze samples of normative linguistic patterning at two age points in the adult segments of the life cycle, (3) to determine if a shift in linguistic patterning occurs between the two age points, (4) to analyze the structure of such a shift, (5) to analyze the similarities and differences between the structure of deficits in normal aging and in senile dementia Alzheimer's type, (6) to develop a conceptual model of language in dissolution, and (7) to see what is the relation between linguistic patterning (Test for Syntactic Complexity, Emery, 1982; Token Test, DeRenzi and Vignolo, 1962; Chomsky Tests of Syntax, Chomsky, 1969; Boston Diagnostic Aphasia Exam, Goodglass and Kaplan, 1972) and measures of other cortical processes such as memory (Wechsler Memory Scale, Wechsler, 1949) and thought (Piagetian Stage Tasks, Piaget, 1952) in the elderly.

Memory, language, thought, attention, and perception are high order cortical functions. Deterioration of higher order cortical functions is at the center of the symptom complex which characterizes senile dementia (DSM-III, 1980), and yet the structural configuration of cognitive deficits in senile dementia is very little known (Appell, Kertesz, & Fisman, 1982).

Dementia is a chief biomedical disturbance of aging (Schneck, Reisberg, & Ferris, 1982). With both the numbers and proportion of old increasing in the total population, there is an increased number and proportion of persons with senile dementia in the total population, and thus an increasing importance of dementia with senile onset as a problem of gerontological research. Estimates

of the prevalence of dementia in the old vary between 5% and 15% (Miller, 1977). The prevalence of dementia is correlated directly with age, and the prevalence rate increases dramatically for persons over 80 years of age, with estimates at 22% (Kay, Bergmann, Foster, McKechnie, & Roth, 1970).

The study to be reported points to the fact that systematic analysis of the higher order cortical process of language results not only in a discriminating tool for differential diagnosis, but also adds to a fundamental understanding of the process of cognitive deterioration in both senile dementia Alzheimer's type and in normal aging.

METHODS/PARTICIPANTS

The research involved the investigation of language patterning in comparison groups of 20 elderly adults with senile dementia Alzheimer's type (ages 71-91), mean age 80.25), 20 normal elderly adults (ages 75-93, mean age 83.35), and 20 normal pre-middle-aged adults (ages 30-42, mean age 36.4) who served as a performance baseline. In addition to controls for age, the variable of sex was controlled with each sample consisting of 10 men and 10 women. Race was held constant; all subjects were white. Cohort differences, such as differential education (Birren & Schaie, 1977; Botwinick 1978; Nesselroade & Reese, 1973) were controlled within and between samples, through the requirement of being no more and no less than a high school graduate. Subjects were native English-speaking Americans with native English-speaking American parents; no bilingual persons were included in the study. Cognitive socialization (Csikszentmihalyi & Emery, 1979; Emery & Csikszentmihalyi, 1981a, 1981b) was controlled across samples also.

Subjects with senile dementia Alzheimer's type (SDAT) were selected from a population of patients having been first diagnosed after age 65. Further sample refinement occured as persons with multi-infarct history, history of stroke, high blood pressure, left-right impairment, space-occupying tumors, and endocrine or metabolic diseases were excluded. Other variables of potential confounding are institutionalization (Kahn, Goldfarb, & Pollack, 1958) and depression (Kahn & Miller, 1978); these variables were controlled across samples. To help distinguish between persons with SDAT and pseudodementia (Post, 1975), the Langner and Hamilton Depression Scales were used; degree of organicity was determined by the Kahn-Goldfarb Mental Status Exam and the Bender Face-Hand Test (Kahn, Goldfarb, Pollack, & Peck, 1960). To make sure that chronic schizophrenics were not included, an Interview for Psychosis (Kahn, Kodish, & Emery, 1978) was administered. Subjects were located through the outpatient facilities of Dartmouth Medical School.

The above criteria applied to normal samples also. Additionally, a history of optimal health was required; no person with compromised major organ systems or

a history of chronic illness was included in the normal samples. Optimally healthy elderly subjects were located with the assistance of several physicians. All persons were given a standard interview which included basic demographic information, personal and medical histories.

MEASURES FOR LINGUISTIC DATA

Language is a system of codes, evolved for the purpose of communication. The use of language involves the processes of encoding and decoding of symbols and signs. Further, language is a system of rules, requiring the mental processing and integration of varying forms and sets of relations.

The formal aspects of language patterning were analyzed in the context of the semiotic system; the system is hierarchical, going from simple to more complex units of speech, with categorical ranks of phonology, morphology, syntax, and semantics (Bloomfield, 1933; Saussure, 1916; Yngve, 1980).

Phonology refers to phonetic and phonemic systems of language both of which involve sound without reference to meaning. Morphology is the study of morphemes; a morpheme is the smallest unit of linguistic signalling which has meaning (Bloomfield, 1933).

Syntax is the analysis of phrases and sentences. Variables of syntax include differing sentence types, differing kinds of clauses, linear word order, pronomial and prepositional usage, and forms of propositional relations. Variation in these syntactic elements can be ordered on the dimensions of complexity-simplicity. logicality-alogicality, and abstraction-concreteness (Brown, 1973, Dale, 1976, Svedelius, 1897). These syntactic dimensions have been used for the testing and discrimination of brain damaged from normal populations by Jackson (1884), Monakow (1910), Head (1926), Goldstein (1942, 1948), Luria (1973, 1980) in relation to accident, war, and tumor victims. Systematic syntactic testing of persons with SDAT or of normal elderly persons has not been done previously insofar as we know.

Semantics refers to that branch of the semitic system which deals with signs and what they denote; semantics refers to the analysis of meaning (Yngve, 1980).

Of the 13 instruments administered to 60 subjects, four were designed specifically for analysis of language patterning. One of these was a test for language patterning at the syntactic level of the semiotic hierarchy; the test is based on the methods of Chomsky (1969). A second measure, designed by the present speaker with the assistance of Dr. Darden, Chairman, Department of Linguistics, University of Chicago, is the Test for Syntactic Complexity; this test provides data at the word-internal morphological level as well as at the syntactic level. The third measure is the Token Test (DeRenzi & Vignolo, 1962; Spreen & Benton, 1969) which provides data at both syntactic and semantic levels. The fourth test is the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) which provides data at phonological,

morphological, and semantic ranks.

The Wechsler Memory Scale (Wechsler, 1949) was given for assessment of memory, and the Piagetian Tests for Thought (Piaget, 1952) were given for assessment of level of cognitive function.

Difference of Means and Difference of Proportions Tests were used to determine statistical significance (Blalock, 1972).

RESULTS [1]

The Token Test consists of thirty-nine verbal instructions which are brief, simple, and yet of increasing linguistic complexity, in which the subject must process relations between tokens of varying size, color, and shape. [2] Increasing linguistic complexity is attained primarily through the use of prepositions ('put the green square beside the red circle', 'put the red circle on the blue square'); prepositions are relatively complex linguistic forms having the concomitant property of late acquisition in language development (Brown, 1973; Dale, 1976). On the Token Test, the mean of the Alzheimer elderly was 26.4 in contrast to the mean of 129.9 for the normal elderly ($t = 13.75$, $p = .0001$). The mean for the pre-middle-aged was 159.9 yielding a difference of means t-value of 5.89 ($p = .0001$) when contrasted with the normal elderly mean of 129.9. When the normal elderly sample is subdivided into a younger half (mean age = 78.5) and an older half (mean age = 88.2), there is a significant difference ($p = .01$) between the younger subgroup mean of 142.4 and the older subgroup mean of 117.3.

The Test for Syntactic Complexity consists of four sections which deal with various syntactic relations which are complex and were late to develop in language learning: (1) prepositions of time sequence ('do you put on your stockings after your shoes'), (2) comprehension of reversible possessive forms ('what is the relation of your sister's mother to you', 'your mother's sister to you'), (3) communication of everyday narrative events ('John and Mary run to the store really fast') versus the communication of logical relationships ('John runs faster than George but slower than Humphrey'), and (4) passive subject-object discriminations ('the wolf was killed the dog, which animal is dead and which killed the other'). The mean of the Alzheimer elderly was 5.35 (perfect score is 36) in contrast to the mean of 24.35 for the normal elderly ($t = 12.88$, $p = .0001$). The mean of the pre-middle-aged sample was 33.1 which yielded s difference of means t-value of 7.58 ($p = .0001$) when contrasted with the mean of the normal elderly. When the normal

[1] For greater detail, see Tables.

[2] Instructions are distributed over six sections which are weighted, with points increasing directly with linguistic complexity for a test total of 163 points. Grading procedures were both the traditional method and a method of dichotomization in which partial credits are not given so as to be able to evaluate semantic performance at level of sentence rather than at level of discrete words.

elderly group was subdivided into younger and older halves, the respective means were 26.2 and 22.5 ($t = 2.12$, $p = .05$).

Chomsky (1969) found that syntax is acquired in development as a direct function of complexity in syntactic structures. Further, Chomsky delineated four conditions under which maximal complexity obtains; these conditions were at the basis of the syntactic test given our subjects. The results show the mean of the Alzheimer group to be 13.25 in contrast to a mean of 57.95 for the normal elderly ($t = 10.64$, $p = .0001$). As with the Test for Syntactic Complexity, the results show, on all subtests of Chomsky's Tests of Syntax, that syntactic regression occurs as part of the dementing process; the Alzheimer elderly were not capable of processing syntactically complex forms (acquired bertween ages 5 and 10) and showed constant evidence of regression toward use of the most simple forms (Stage I, Dale, 1976) of syntactic patterning. The mean of the pre-middle-aged was 90.35 (perfect score is 100) which results in a significant difference of mean between the pre-middle-aged and normal elderly ($t = 9.19$, $p = .0001$). The younger half of the normal elderly had a mean of 68.5 while the older half had a group mean of 47.4 ($t = 5.29$, $p = .0001$).

On the Boston Diagnostic Aphasia Exam there were no significant differences between the normal elderly and the pre-middle-aged. In contrast, there were highly significant differences between the normal elderly and the elderly with Alzheimer's dementia. Relative to themselves, the Alzheimer elderly did better on the Boston Aphasia Exam than on the other three linguistic instruments. Within the Boston Aphasia Exam, the Alzheimer performance was variable, depending on the semiotic content of the subtest (see Tables).

On all measures, there was a direct correlation between organic deficit in the Alzheimer elderly (as measured by Face-Hand Test and Mental Status Questionnaire) and performance deficit; the Pearson correlations between the Face-Hand Test and the Token Test, Test for Syntactic Complexity, Chomsky Tests of Syntax, Piagetian Tests for Thought, and Wechsler Memory Scale were .868, .761, .734, .630, and .928 respectively.

For the normal samples (normal pre-middle-aged and normal elderly combined), the Pearson correlations between age and raw scores on Token Test, Test for Syntactic Complexity, Chomsky Tests of Syntax, Piagetian Tests for Thought, and Wechsler Memory Scale were -.73, -.79, -.86, -.73, and -.71.

Finally, the normal elderly sample was broken down into two groups of ten persons each along the parameter of regular mental activity, both current and across time (reading, cross-word puzzles, journal and/or diary writing, mathematical manipulation). The difference of means yielded a t-value of 3.13 with a significance level of .01, thus suggesting that regular mental activity might serve as an intervening variable between age and its concomitant of higher order cortical decline.

The present study shows that higher order cortical deficit is not random. Looking at the linguistic data generated by the study, what is the pattern of deficits associated with senile dementia Alzheimer's type.

The study shows that the Alzheimer elderly did best on tasks requiring only repetition. The Alzheimer patients treated the requirement for repetition as a phonological task in which there occurs the repetition of sounds without the processing of meaning. The next best forms of structured performance were automatized sequences and other rote tasks; these forms require minimal integration of meaning with sound. The data consistently show an inverse correlation between adequate linguistic performance and requirement for integration of meaning with sound. The best performance of the Alzheimer elderly is at the phonological level of the semiotic hierarchy, the level of sound without meaning.

At the morphological level the functioning of the dementia sample was significantly worse than at the phonological level ($p = .002$), but far superior to function at the syntactic level ($p = .0001$). To the degree that performance at the lexical-morphological level (level of words) could be done in an automatized manner in which there was required a minimal integration of thought with sound, to that degree there was less performance deficit.

At the syntactic level, the elderly with Alzheimer's were incapable, totally, of processing complex syntactic forms, with evidence of regression toward exclusive use of the most elemental patterns of syntax. The Alzheimer elderly answered incorrectly almost all items relating to syntax.

At the semantic level, the integration of sound with meaning is, by definition, required. This integration can be analyzed at the unit level of the word and the unit level of the sentence. It has been pointed out that the best performance at the level of vocabulary occurs under conditions of automatized treatment of lexicon. At the level of the sentence, the data show that the more abstract, logical, and complex the structure of the sentence, the greater the decrement, and the less the decoding of meaning. Maximal semantic processing for the elderly with Alzheimer's has a direct relation to simplicity and concreteness in code.

To sum, there is a direct relation between linguistic deficits and linguistic complexity, both within the ranks and across the ranks of the semiotic hierarchy. Further, there is the concomitant inverse relation between sequence in language development and subsequent deterioration, i.e. the later the developmental acquisition of a linguistic form, the greater the linguistic complexity, the earlier the linguistic deterioration. Related to this is the inverse correlation between adequate linguistic performance and necessity for integration of meaning with sound.

Vygotsky (1962) made the original observation that thought and language represent two separate lines of development until the age of two years, after which the

two developmental lines intersect and become merged. The results from the present study suggest that senile dementing is a process in which the two lines of thought and language, or to use our terms, meaning and sound, which were at one point in development merged, once again are separated or in the process of separating. This finding is germaine for explaining what DSM-III (1980) refers to as language in senile dementia which is "vague, stereotyped, and imprecise, with long circumlocutory phrases" (p. 109); once it is realized that senile dementing involves the process of separation of meaning from sound, various symptoms of the pathology become comprehensible.

The findings of this study suggest there is a fundamental correlation between degree of organic impairment and degree of linguistic decrement; there is a direct relation between normative denotation and connotation and organic intactness. The process of senile dementing appears to be a process of dedifferentiation in which the person can no longer respond to complexities of the cortical realm. From the earliest beginnings of ontogenetic development, a person is socialized (Csikszentmihalyi & Emery, 1979; Emery & Csikzentmihalyi, 1981a, 1981b) into the normative use of language; the progressive incapacity of the old person with Alzheimer's dementia to code and decode within the normative range is akin to a process of desocialization. Language is a system of rule-governed or socialized behavior; senile dementing is a process which destroys progressively the capacity for participation in rule-governed or socialized behavior.

Normal Elderly

Other investigators have documented that the higher cortical processes of memory (Anders & Fozard, 1973; Botwinick & Storandt, 1974, 1980; Craik & Simon, 1980), perception (Bender, 1975; Foley, 1975), and thought (Denney & Denney, 1982; Denney & Wright, 1976; Horn & Donaldson, 1976, 1977; Papalia, 1972, Poon, 1980) undergo deterioration as a function of normal aging. The contribution of the present study to the literature on normal aging is in the idea, as well as in the data, that the higher order process of language also undergoes deterioration as a concomitant of normal aging.

The results of the present study show that the normal elderly perform significantly less well than normal pre-middle-aged adults on linguistic measures (Test for Syntactic Complexity, Chomsky Tests of Syntax, Token Test), as well as on measures of memory (Wechsler Memory Scale) and thought (Piagetian Tasks for Concrete Operations); the data indicate a direct relation between increased age and performance deficits.

Finally, the study provides a finding that regular mental activity, across adults years, seems to modify the direction relation between age and higher order cortical dysfunction; the intervening variable of mental activity appears to temper the effects of age upon synthetic mental functions.

Comparison of Test Means by Sample

Sample		Mean Age	TT	TSC	CTS	PT	WMS
Maximal Score Possible			163	36	100	5	82
Pre-Middle-Aged		36.40	159.90	33.10	90.35	4.5	62.00
Normal Elderly		83.35	129.85	24.35	57.95	2.7	47.10
Alzheimer Elderly		80.25	26.40	5.35	13.25	.6	11.68
Pre-Middle-Aged							
Normal Elderly	t-value		5.89	7.58	9.19	5.92	5.35
	significance		.0001	.0001	.0001	.0001	.0001
Normal Elderly							
Alzheimer Elderly	t-value		13.75	12.88	10.64	6.25	12.43
	significance		.0001	.0001	.0001	.0001	.0001

Note: N equal 20 per sample, df equal 38 for Difference of Means Tests (Blalock, 1972).

TT -Token Test
TSC -Test for Syntactic Complexity
CTS -Chomsky Tests of Syntax
PT -Piagetian Tests for Stage of Thought
WMS -Wechsler Memory Scale

Prevalence of Chronic Brain Syndrome
(Dementia) in Newcastle-Upon-Tyne

Age (years)	Prevalence (percentage)
65-69	2.3
70-74	2.8
75-79	5.5
80+	22.0
Total	6.2

Data taken from Kay, Bergmann, Foster, McKechnie, and Roth (1970)

Distribution of Raw Scores by Face-Hand Test

Elderly with Alzheimer's Dementia

Occupation	Age	FHT	MSQ	TT	TSC	CTS
Maximal Score Possible		16	13	163	36	100
Street Department	71	10	8	78	18	40
Croquet Factory Work	78	9	4	62	11	43
Truck Driver	79	9	5	72	5	10
State Agency Clerk	76	7	5	30	9	31
Accountant	85	7	3	62	6	12
Foreman-Saw Mill	75	6	4	30	11	12
Physical Therapist	80	6	6	49	5	11
Owner-Notions Store	84	6	4	27	14	22
Nurse	76	5	7	5	4	19
Housewife	91	4	5	32	4	9
Dry Goods Clerk	83	1	2	12	2	8
Paralegal	75	0	0	9	3	0
Housewife	75	0	1	35	8	10
Store Manager	78	0	0	4	1	0
Teacher-5th Grade	79	0	0	2	0	16
Banker	80	0	1	7	3	6
Gym Teacher	80	0	0	5	3	0
Housewife	84	0	2	4	0	16
Housewife	86	0	0	3	0	0
Drummer-Band	90	0	0	0	0	0

FHT -Face-Hand Test
MSQ -Mental Status Questionnaire
TT -Token Test
TSC -Test for Syntactic Complexity
CTS -Chomsky Tests of Syntax

Pearson Correlations Between Face-Hand Test and Linguistic Measures

Elderly with Alzheimer's Dementia

Face-Hand Test		Linguistic Measure	r	p
Face-Hand Test	versus	Token Test	.868	.01
		Test for Syntactic Complexity	.761	.01
		Chomsky Tests of Syntax	.734	.01

N = 20

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